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**PRODUCTS OF ANIMAL
AND PLANT ORIGIN
AND SUBSTITUTES**

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PRODUCTS OF ANIMAL AND PLANT ORIGIN AND SUBSTITUTES

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INTRODUCTION

1. The present paper deals with some essential aspects of the utilization of some vegetable and animal substances in UAR, in the production of some edible oils, corn-starch and sugar industries. Some problems concerning these industries will also be briefly discussed.

PART I

EDIBLE OILS

2. Fats and oils play an important part in Nature's scheme to support and sustain life. Many of them have yet no commercial significance, others are of purely local importance.

3. In the UAR, the cottonseed is the main source of oil industry. The amount of oils extracted from cotton and other seeds is about 91,000 tons every year, that of cottonseed oil produced locally is 89,200 tons. Cottonseed kernels, the source of the oil, contain a strong deep brown colouring matter, and the crude oil escaping from the press has a ruby-red colour which is so intense that it appears sometimes to be nearly black. The oil is refined and decolourized by submitting it to a partial saponification by heating with a solution of caustic soda of suitable concentration. A sort of defection occurs and the soap which is formed carries away the colouring matter. In this connection three types of cottonseed oil are produced by the Egyptian industry. The "English" oil is produced by heating the crude oil with caustic soda solution. This type of oil accounts for more than 80% of the production and is used for edible purposes and for the manufacture of soap. After further refining by decolorizing and deodorizing the golden yellow oil is sold under the trade name "Sultane", and is utilized exclusively for edible purposes. The third type, known as "French Oil", is a completely refined product destearinised by a process of refrigeration and filtration.

4. The object of refining and bleaching is to remove the objectionable impurities in the oil with the least possible damage to the glycerides or to the tocopherols or other anti-oxidants. Crude cottonseed oil, as reported by Jamieson & Baughman (1),

(1) Jamieson, O.S., & Baughman, W.F., 1920: Cotton Oil Press, 4, No.3, 61-3.

contains the following constituents: raffinose, pentosans, resins, proteoses, peptones, phosphatides, phytosterols, inositol phosphate, xanthophyll and free fatty acids.

5. The laboratory refining loss test of cottonseed oil does not reveal how much refined oil will be yielded by the crude oil when the latter is actually processed in the refinery. In addition to free fatty acids, carbohydrates and the above mentioned constituents of the crude oil are also removed by refining, and there is invariably lost, through saponification and emulsification, a certain amount of neutral oil. This amount changes according to the variability of the surface-active properties of some of the non-glycerine constituents. Likewise crude oil with similar contents of free fatty acids and total nonoil substances may yield refined oils with different depths of colour. A true indication of the value of the crude products can, therefore, be obtained only by means of small scale refining tests.

6. In this connection, the editor (2), studying the effect of hot-air treatment of cottonseed as it is followed in the UAR, has noticed that it had a slight effect upon some of the properties of oil, although the acid value was slightly higher in the oil extracted from the treated seed. The editor (3) also studied the effect of different refining treatments on the yield of the crude oil as well as the various physical and chemical constants of the oil extracted from Egyptian cottonseeds representing the important strains of cotton (Ashmouni, Karnak and Menufi). All the seeds had been treated previously by hot air as requested by law. The seeds of each variety in the first group were crushed separately, then air-dried at 105° for one hour to determine the oil content, other samples of each variety were crushed, then cooked with steam at 92°C. and then pressed hydraulically at 4480 lb/sq. in.

7. Physical and chemical constants were determined in the crude oil of each variety. In the second group the percentage of the dead seeds (red seeds) was determined by calculation; according to the dead seed content and the acid value of each variety of oil, a mixture was made from the seeds of the three varieties in the proportion 50:25:25 for Ashmouni, Karnak and Menufi respectively. The mixed seeds were crushed as received without removing the fibres and then cooked with steam as mentioned before. The crude oil was allowed to settle at room temperature for 24 hours, and acidity was determined and found to be 2.584 as oleic acid. Accordingly the required amount of alkali for neutralization was calculated (16.5ml NaOH, 16Bé) for each 500gm of crude oil. However, neutralization was carried out in three steps, the resulting refined oil represents three kinds of the grade "English" or "No.3" oil as is known in commerce:

English I,	16.5ml NaOH	(100% of calculated required amount)			
English II,	12.4ml NaOH	(75%	"	"	")
English III,	20.6ml NaOH	(125%	"	"	")

(2) Kamal, M.A.M., Ann. Agr. Sc. Fac. Agr., Ain Shams Univ. Cairo Vol.3 No.3 (1958)

(3) Kamal, M.A.M., Ibid, Vol.2 No.1 (1957).

Each amount of caustic soda was added to 500Gm of the crude oil, stirred at 40°C for 20 minutes at 70 rpm, and then filtered with filter paper. No washing was used to avoid gain of moisture and to enable further determination. The weight of the soapstock (mucilage) was determined and accordingly the refining loss per cent was calculated. Each kind of the refined (English) oil was bleached by heating 100Gm of the oil at 90°C, adding 2% of its weight Fuller's earth, then stirring at constant temperature for 15 minutes at 120 rpm, and then filtering with filter paper. The resulting three kinds of oil; Bleached I, Bleached II, Bleached III, represent the oil grade known in commerce as No. 2 Oil. No deodorization was used in order to enable further determination of the iodine value.

8. The results showed that the dead seeds have a lower oil content with higher acid value than alive seeds. It should be stated here that the cottonseed grade is usually evaluated according to the percentage of red (dead) seeds present in each sample. The seeds under investigation contained 9.28, 14.89, 21.20% of dead seeds for the varieties Ashmuni, Karnak and Menoufi, respectively.

9. Investigated cottonseed lots differed mainly in their oil content and the acid value of the crude oil. Ashmuni seeds had the highest oil content (24.6%) with the lowest free fatty acids (1.724 as oleic), while Menoufi seeds had the lowest oil content (20.1%) with the highest acid value (4.204 as oleic). This may be attributed to the variations in the dead seed content in each variety lot. Slight acidity was found in all kinds of refined oil, although the acid value decreased considerably when the amount of caustic soda used for neutralization was 125%. This may be due to the partial hydrolysis of the glycerides caused by the rise of temperature or by the uptake of some of the alkali in partial saponification.

10. The effect of bleaching revealed a very slight increase in acidity, and this may be due to the acidic effect of Fuller's earth used. It is interesting to mention that a consistent relationship between free fatty acids and the average refining loss was noticed, and this relationship was conversed when the amount of NaOH used for neutralization was increased.

11. With regards to the constants of the oil it was noticed that iodine value and refractive index were not influenced by the different refining levels of NaOH, and the value of these constants, however, in the three levels of bleached oil was lower than in the three levels of English oil of the same sample. Saponification value did not show any variation during the different refining treatments, and the unsaponifiable matter in different grades of oil ranged from 1.3 to 1.8. No clear effect was noticed due to the effect of refining treatments.

12. The amount of oil produced from oleaginous seeds and its constituents are largely affected by the method employed in extraction. The mechanical methods which involve the use of hydraulic pressure usually produce a low yield of oil. There is a great

number of solvents that could be used for extracting oily materials, and it is obvious that the degree of extraction depends largely on the nature of the solvent and the temperature employed during this process.

13. Work on this problem, by the editor, using cottonseed oil (Karnak and Ashmuni varieties) showed that the amounts of oil extracted with different solvents were not similar. Carbon disulphide and petroleum ether, exhibited the same extraction power with cotton seed. In general the solvent extraction process showed its superiority over the hydraulic pressure method. The quantity of the unrecovered oil by the hydraulic pressure method in terms of percentage of the total oil increased progressively as the oil content of the seed decreased. The loss in the yield in cotton seed varieties ranged between 22.1% and 24.3%, for Karnak and Ashmuni respectively.

14. With regards to the various constants of the oils under investigation it was noticed that the specific gravity and the refractive index of oils produced by means of solvents were lower than those values reported for oil produced by the mechanical press. Petroleum ether and carbon disulphide produced oils with a low iodine value. This emphasises the fact that the unsaturated fatty acids in the glycerides of cotton seed oil are quite different from those of olive oil. It may be worth mentioning that the data on cottonseed oil revealed that the acid value of the oil produced by mechanical pressure was higher than that extracted with solvents. Hexane gave the lowest free fatty acid content among the other solvents. This leads to the impression that hexane is regarded as the best solvent for the production of oil with the lowest possible acidity as far as this investigation is concerned.

15. In this connection it should be mentioned that the crude oil content of the different varieties of Egyptian cotton seeds ranges from 24.41 to 27.61%, calculated as percent of dry matter and as determined in the hulled seeds. It is worth noting that the oil content appeared to be mostly an inherited property of the variety.(4) It seems also that the varieties of Ashmuni type (short-stapled cotton seed) possessed the highest oil content among the other types grown in the UAR. Since the average apparent local consumption of oils and their products amounts to 125,000 tons, it appears that there is a lack in local oil production amounting to 34,000 tons. Therefore it was necessary to search for new oily seeds or new oily sources and to improve the methods of extraction in order to help supply the oil production and industry in the UAR.

RICE BRAN- and CORN-OILS

16. The oil produced from some cereals and other oleagenous kernels such as sesame, sunflower, peanuts, and prickly lettuce will offer an excellent solution to help supply for oil production in the UAR and other countries.

(4) The editor: Kemal, M.A.M., Ann. Agri. Sc. Ain Shams Univ., Cairo, Vol.3, No.2.

Rice Bran Oil

17. The annual world production of rice is about 200 million tons. The total consumption of rice in the UAR is nearly 682,000 tons of milled rice coming from 991,000 tons of paddy, taking into consideration that the milling extraction factor for rice is about 66%. Two varieties of rice are cultured in the UAR, the long-grain and the short-grain.

18. Rice barn, the by-product of rice milling, amounts, in the UAR, to 90,000 tons, produced annually from 64 mills. The short-grain rice variety contains a high amount of bran, 7.5% while the long-grain variety contains about 5.9%, and the oil content of bran ranges from 13.12 to 18.03%. It was found that bran from short-grain rice has a comparatively higher oil content.

19. Generally speaking the oil in bran is 12%, and in the embryo about 13%; both percentages are approximately 2% less than the American rice bran. The crude rice bran oil contains 10.5% waxy substances. The extracted oil showed the following characteristics (5): Sp. Gr. 0.9289 (d 30°), Ref Index 1.4696 acid value 17.24, Sap. value 18.3, Iodine value 93.60, and the rice bran consists mainly of 48.36% oleic, 27.60, and the rice bran consists mainly of 48.36% oleic, 27.64% Linoleic and 19.44% saturated fatty acids.

20. The rice bran oil is produced by the solvent extraction method. The extraction of the oil by commercial hexane followed two rates, 50% of the oil content was extracted by the first rate (diffusion) in a few minutes (5-10 min), and the second rate (dialysis) is comparatively slow. The lower alcohols are better than hydrocarbons and 2-propanol is preferable to ethanol for its miscibility with rice bran oil.

21. The main problem with extracting oil from rice bran is that fatty acids form quickly on separation of the bran from rice bran is that fatty acids form quickly on separation of the bran from the rice grains, and oxidative rancidity is also taking place. This could be overcome by heating the bran to near dryness to hinder the enzymatic activity. In this connection the rice husk could be used as a fuel for this purpose. So, we suggest that drying ovens must be placed near or inside the mills.

22. Well stored bran should contain only 3-5% of humidity. The expenses of this procedure can be solved in UAR by raising the price of milled rice from 39 to 40 mills.

23. In this connection, the effect of steaming fresh paddy rice on the development of free fatty acids during storage of brown rice has been studied by several workers (6). Enzyme inactivation appeared essentially complete after steaming. The use of par-boiled rice, also, offered advantages for studying the processes of deterioration in cured grains. It is worth

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- (5) Hinawy, S.I., Ph.D. thesis, Ain Shams Univ., Cairo (1957)
(6) Houston, D.F.; Hunter, J.R. & Kester, E.B., Cereal Chemistry, 394 (1951).

to mention that the par-boiling process is about to be introduced in the UAR. In July 1963 the first par-boiling factory will be finished, at Mehalla, and its annual capacity will be 20,000 tons of paddy. Another factory is to be built, and it will export to Ceylon about 50,000 tons every year (L. 34 per ton).

Corn Oil

24. Maize- or corn-oil is obtained only from the germ (scutellum) which is commercially separated from the endosperm by several processes before pressing. The oil content of the whole fruit ranges 3-5%. It was found that the oil content in some different varieties and strains, grown in the UAR, ranges from 4.79-6.38%, and the amount of oil seems to bear some relation to the weight of seeds. Reports from the Ministry of Agriculture indicate that the oil content of corn kernels is higher in the open pollinated varieties than in those produced from double crossing.

25. Corn oil is produced as a by-product in factories making starch from maize. In this connection it should be mentioned that the cultured area of maize in the UAR is 1,850,000 feddans, which produce about 1,499,000 tons of maize, with an average of 88 tons per feddan. All these amounts are consumed in knead making and materials other than starch and its products. Thus, the starch industry from corn, i.e. the corn oil production, in the UAR depends only upon imported corn. There are three factories in the UAR specialised in starch industry from corn. The largest factory (Sirpakis) produces 45 tons daily of glucose syrup, 10 tons of starch, 4 of oil, 25 tons of feed and 7 tons of cake. The corn needed for this factory, at the present time, is about 60,000 tons of imported corn, and this quantity is about half the actual production capacity. The tone of crude oil is sold for about L.E. 120, but the pure oil is sold for about L.E. 400 per ton.

26. The keeping qualities of this oil are fairly good, but the crude oil is easily hydrolysed if meal is present. The iodine value of corn oil ranges from 110-125, the saponification value is about 190 and the free fatty acids (so oleic) about 3%. It contains about 0.9 - 2% unsaponifiable matter. In the UAR corn oil is expensive because of the shortage in corn quantities available for starch industry. In this connection researches are being carried out, in the UAR, concerning the use in medical purposes, so that it is still sold only in pharmacies. Thus it is of great importance to increase the cultivated area of corn in the UAR, or to cultivate other suitable oleagenous crops.

Other Sources of Edible Oil

27. Attention should be paid to sunflower seed production; it is considered as one of the best sources of oil as well as animal feed. The editor showed that the sunflower varieties cultivated in his experiment (7) yielded from 720, to 916 Kgm. seeds per feddan, with crude oil contents 26.74, to 29.15%.

(7) Kamal, M.A.M. & Damaty, Ann. Agric. Sci. Fac. Agric., Ain Shams Univ., Cairo, Vol.II, No.1 (1957).

The average oil content of the different varieties of pure strains of Egyptian cottonseed was lower by 2% than the average oil content of sunflower seed and by 6-8% than the commercial grades of cottonseed. The editor also noticed that the crude filtered oil of sunflower seed varieties under investigation contained a very little amount of free fatty acids, and the crude filtered oil, obtained by the mechanical press, of the different varieties of sunflower seed is as very clear, had a bright yellowish colouration and was characterized by its good flavour and odour. It was also noticed during this study that no further acidity occurred owing to the ageing of the crude filtered oil. This is of great importance from the economical point of view.

28. It is interesting to mention that the Ancient Egyptians cultured an important oily crop which is known as *Lactuca scariola* (prickly lettuce). There is no doubt that the varieties growing now in the UAR originated from the ancient varieties, and it is only cultivated in Upper Egypt near Kena and Asswan. Although the nutritive value and oil content of the seeds of this crop are undoubtedly high, yet the cultivated area in the UAR is very small and does not exceed 1000 feddans. This oil is used in those regions as butter or "Samma" substitute, and it is known as "Sweet Oil" or "Oil of Cows". All kinds of soil are suitable for the cultivation of this crop, and it is cultivated either alone or mixed with other leguminous crops. The yield of oil varies widely with the type of soil. In the UAR it is cultivated in November and harvested after almost six months. The feddan yields about 600 Kgm of seed. Preliminary studies carried out by the editor showed that the oil content of some black-seed varieties is about 49% of crude oil. In general the oil content ranged from 30-38%. This wide range is due to the effect of variety and type of soil and locations. The average values of some physical and chemical constants of the varieties of prickly lettuce seed oil, investigated by the editor and co-workers, are: Sp.Gr. 0.9377, ref. ind. 1.4733, sap. value 190 and iodine value 129. The leaves of the crop, and cake of seeds, after oil extraction, are used for animal feeding in UAR. It is interesting to note that this crop is irrigated only once throughout the whole season of growth; this is of great importance to pay attention to such inexpensive oily crops.

PART II

CARBOHYDRATE INDUSTRIES IN THE UAR

Some Problems in the Manufacture of Sugar Cane and its Products.

29. Sugar cane is an important agricultural crop in the UAR, also it is the principal crop in Kena and Asswan as well as some parts of Menya and Assyout. Sugar manufacture is a successful national industry because it is a major consumer product. The average per capita consumption of sugar in the UAR is 14-15 Kgm. per year; this is covered by the local plantations.

30. Statistics for the year 1961 show that the total area under sugar cane was 85140 feddans; the average crop per feddan was 43290Kgm; the amount used up by the sugar industry was 3531581 tons; the amount of sugar produce was 363028 tons. New planning was put to make use of as much as possible of the land that

will be irrigated by the High Asswan Dam in the production of cane, to increase the capacities of the 4 factories already present in Kom Ombo, Armant, Nag Hamadi and Abu Korkas and to build 4 new ones in Edfu, Kous, Kena, and Baliana so that the UAR would become a sugar exporting country. Since 1952 the area of land planted with sugar increased from 64248 to 85140 feddans, cane yield per feddan increased from 32.3 to 41.3 tons, and the average sugar yield per feddan increased 2.94 to 4.25.

31. In UAR by-products of sugar industry are utilized in producing ethyl alcohol, vinegar, glacial acetic acid, perfumes and cosmetics. New industries arising are dry yeast and pressed wood manufactures.

32. The problems encountered in the manufacture of sugar in the UAR are the following:

- (a) Improving the present species or finding others known to have a high sucrose content and a low fibre content.
- (b) Increasing the tonnage per feddan by improving agricultural treatment of the land, especially by the use of fertilizers.
- (c) Increasing the sugar yield per feddan. This can be achieved by not leaving the cane to over-mature in the soil, and by harvesting it at the proper time in order to avoid the inversion of sucrose into non-crystallisable reducing sugars which are of no use to the industry.
- (d) Early delivery of the cane to the factory after harvesting. If left for more than one day, before delivery, inversion of sucrose will occur.
- (e) In the UAR cane is grown by budding. This leads to gradual deterioration of the species in the following years. The Ministry of Agriculture is attempting to encourage cane, grown in special greenhouses, to flower and to produce seeds, by supplying optimum of temperature and humidity.
- (f) A problem which has been solved in the UAR is that of choosing the most representative joint stalk for analytical purposes. This has been found to be the fifth or sixth joint from the top of the stalk.

33. The analysis of the juice obtained by a three roller mill is as follows: total solids 21%, sucrose 12.93%, reducing sugars 1.54%, ash 37%, albuminoids 18%, free acids 0.1%, combined acids 14%, gums 0.1%. The commercial sugar contains 0.07% reducing sugars, 11.0% ash, water 0.7%, organic matter 0.03% with 99.75 polarisation.

34. Molasses which results from sugar manufacture is used for many purposes: manufacture of all kinds of distillates, production of chemicals such as acetic acid and potassium salts, as well as a food-stuff. The composition of molasses is as follows: Total solids 90.5%, water 9.5%, sucrose 39.4%, reducing sugars 14.3%, and organic matter 27.3%. Researches are carried out

concerning the use of cane molasses in the industry of citric and itaconic acids, and of antibiotics using microbiological methods (8).

Other Sources of Sugar

35. It is necessary to introduce new sugar-containing plants, other than cane, in order to boost sugar production in the UAR. Reports on the preliminary experiments carried out by the Egyptian Ministry of Agriculture in 1959 indicated that sugar beet could be successfully grown in sandy and saline soils, whereas sugar cane, under the same conditions, is practically unable to develop to its normal growth. In addition it is well known that the sucrose content of sugar beet roots is about 17% of the fresh weight, while the figure for sugar cane is about 12%; similarly the ratio of extraction of sucrose from sugar beet is higher than that for cane. This is due to the difference in the method of sucrose extraction from each.

36. Experiments were carried out to investigate the effect of fertilizer treatments on the growth and carbohydrate fractions of sugar beetroot plant grown in sand cultures. Results concerning the weight of beet root and sucrose content in the final stages of growth revealed that roots grown under favourable conditions of Potassium levels (18 mEq) showed maximal growth (569 Gm per root) with the highest sucrose content of 19.56%. It is worth mentioning that beet root is cultivated twice a year, in June and October, and that the average yield per feddan per crop is 15 tons, i.e. 30 tons could be obtained from one feddan in one year. The cane crop which occupies the land for about one year yields about 30 tons of cane with a sucrose content of 12%.

CORN STARCH INDUSTRY IN THE UAR

37. Corn starch is the principal industrial starch in the U.S.A., which is considered as the largest producer of corn starch. Nearly 210 billion pounds of corn are produced annually in the U.S.A., and about 3% of this is milled to make starch and products derived therefrom. Starch per se comprises half of the milled quantity while the other half is used for making sugars, syrups and dextrans.

38. In the UAR the area cultivated for corn production is about 1,850,000 feddans, and the annual production is about 1,499,000 tons, (88 tons per feddan). All these quantities are consumed for bread making, especially in the village. Thus, corn starch production, in the UAR, depends mainly on imported corn. About 70,000 tons of corn are imported every year. This quantity does not cover the actual need for complete production capacity of corn starch in our factories. In this connection it should be mentioned that there are six factories for starch production in the UAR. Three are concerned with corn starch production; one of them uses sweet potatoes as a source of

(8) Shimi, I.R., Faculty of Science, Ain Shams University, Cairo

starch. The other two use rice for starch production. The most important corn starch producer is the National Starch Industry Co. (Syrpakis). The actual production of this factory 8,800 tons of starch and 26,000 tons of glucose syrup annually. The daily production of this factory of corn products is as follows: 45 tons of glucose syrup, 10 tons of starch, 4 tons of oil, 25 tons of feed and 7 tons of cake. The amount of imported corn consumed by this factory is about 34,675 tons, while the amount required for full production capacity is 60,000 tons at the present time.

39. As mentioned before, the starch industry in the UAR depends mainly on imported corn, and to solve the problem the cultivated area of corn in the UAR, must be increased, and species and hybrids that yield abundantly should be selected. Another suggestion is to replace corn, as a main food-stuff, with another crop beside increasing the imported quantities, for the time being, and giving the facilities from exporting countries to the UAR to fulfill its production of corn starch. Another difficulty which we are meeting is the machinery and spare parts. The UAR, if provided with machines and spare parts, either imported or locally produced, will surely increase its yield of starch.

40. As mentioned before in "Corn Oil Production", the corn starch is produced, in the UAR, by the sulphur dioxide method. It is an essential rule in the manufacture of starch to replace the associated nitrogenous substances quickly, by centrifugal methods, to prevent the change which happens owing to fermentation or acid formation. The protein matter, or gluten, amounts to 8-10% and consists of water-soluble albumens, soluble globulins, protamines and alkali-soluble gluteline. Most of them could be separated as the substantially water-insoluble gluten, but soluble globulins and albumens are removed from the corn when it is steeped at the beginning of the process. This steeping water also contains soluble salts which form some 33% of the solid matter removed at this stage. The water soluble extract of corn grain has a pH value of approximately 6.0-6.5. About one third of the dry substance is composed of low molecular weight carbohydrates. These may be fermented by bacteria associated with the grain when it is steeped in the warm acidulated water used in early stages of wet milling. The chief product of fermentation at the temperature employed is lactic acid. The acids tend to hydrate the protein of the grain and to solubilise the alkaline earth salts. The phytates may be split into phosphates and inositol, and the proteins into the usual degradation products: peptones, amino acids

and ammonia (cf. Kerr, 1950: ChemF & Industry of Starch) Thus the steep liquor of corn in starch industry is of valuable biochemical values. Further study and investigation concerning the biochemistry of steeping liquor is being carried out (9).

(9) Kamal, M.A.M., and Shimy, I.R.